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Dressings by Sterilization  
with Heat. Antiseptics  
as used in the Woman's  
Hospital, Brooklyn,  
N. Y.

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GYNAECOLOGICAL SOCIETY, ETC.

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## THE PREPARATION OF SURGICAL DRESSINGS BY STERILIZATION WITH HEAT.

ANTISEPTICS AS USED IN THE WOMAN'S HOSPITAL,  
BROOKLYN, N. Y.\*

By CHARLES N. DIXON JONES, M. D.,  
SURGEON TO THE HOSPITAL; FELLOW OF THE BRITISH GYNÆCOLOGICAL  
SOCIETY, ETC.

GENTLEMEN: It is no longer an hypothesis, but a definitely settled scientific fact, that suppuration can not be caused by chemical irritants; and it can be clearly demonstrated that wherever there is the formation of pus, micro-organisms have been at work. To paraphrase the law of Virchow, without the action of living bacteria there can be no suppuration.

We may go further and state that certain micro-organisms have been proved to be the *cause* if not the actual *materies morbi* of the greater portion of diseases which affect the human race. To the medical man the study of the micro-organisms concerned in these processes becomes a subject of paramount interest and importance.

As practical sanitarians and surgeons, it is desirable to know that the favorable conditions for the growth and de-

\* Read before the Section in Surgery of the New York Academy of Medicine, January 9, 1888.



velopment of disease-producing bacteria are dead organic matter, a limited supply of oxygen, water, and salts. And hence it follows that scrupulous cleanliness, effectual drainage, perfect ventilation, with copious supplies of sunlight, are of the utmost importance for all places of habitation, and especially hospital wards and sick-rooms.

There would soon be an end to all animal life but for the domination of physiological energies and the greater resistance offered by living tissue to the inroads of these parasites, which present a striking "resemblance to beasts of prey in that they first kill and then devour."

It is thus seen that every cause which tends to weaken the physiological force of the human organism, which reduces the vitality, prepares the way for a "fatal assault by swarming multitudes of pathogenic bacteria." Numerous experiments, extending over a period of several years, have been made by different observers, in order to determine the ætiology of the pus-forming process in man. Before bacteriological science had reached that perfection of method which it has now attained, such experiments as those of Councilman and others seemed to show that the simple introduction of irritating substances into the animal tissues was sufficient to set up a process of inflammation followed by suppuration and general infection. Klemperer and Scheuerlin, thinking that the results obtained by other observers might be due to imperfect sterilization of the skin of the animal experimented upon, performed a series of experiments, employing a more perfected technique, and both came to the conclusion that no suppuration would occur without the presence of micro-organisms. These observations have been confirmed by Straus, Becker, Chauveau, Krause, and Ruys.

Dr. Herman Knapp, in an admirable paper read before the Academy of Medicine in December of last year, shows



that fermentation and putrefaction are always dependent upon the action of living bacteria. But the question of the parallelism of suppuration with the other two processes is the principal topic of the author's studies, which he experimentally investigates under three heads: 1. Does traumatism of any kind produce suppuration? In answer to this question he says: "In extraction of cataract (in rabbits, of course) I have purposely bruised and lacerated the iris, evacuated almost all the vitreous, then stirred up the rest with a platinum needle that had been previously brought to a glow, and finally scratched with the same needle the ciliary processes in every direction, yet no suppuration ensued, whereas the smoothest and most cautious operations were invariably followed by suppuration when the wound was contaminated in some way by pyogenic fungi." From this and other experiments he concludes that mere traumatism never causes suppuration. 2. Do foreign bodies as such cause the formation of pus? Foreign bodies introduced antiseptically into the anterior chamber of the eye never caused inflammation and suppuration. In answer to the third question, Are there any kinds of chemical agents that cause suppuration? he reviews the experiments of other investigators, and then relates a series of experiments of his own where chemical irritants were introduced with great precautions into the anterior chamber and under the skin, completely confirming the results of other investigators and concluding that suppuration in every case depends upon the action of living microbes. In this way the parallelism of the three processes—fermentation, putrefaction, and suppuration—is established.

Dr. Harold C. Ernst, in a most interesting and convincing paper, relates the results of a series of some forty inoculation experiments extending over a period of a year or more. In these experiments pure cultivations of seven

different forms of bacteria were used. Inoculations of pure gelatin cultivations of the *Staphylococcus pyogenes aureus* injected into a healthy guinea-pig produced death in twelve hours, and so in every case the experiments indicated that the virulence of these pathogenetic organisms was just as great at the end of a year, and after passing through a large number of generations, as when taken from their birthplace; and he concludes that no form of suppuration in man is unattended by bacteria. And lastly there are the experiments of Prudden on the ætiology of ulcerative endocarditis; the injection of *Staphylococcus pyogenes aureus* into the blood, combined with chemical or mechanical irritation of the valve or the endocardium, almost invariably produced ulcerative endocarditis.

Brassowski has corroborated the investigations of previous observers in a series of observations made at Mikulicz's clinic, and found that the *Staphylococcus aureus* and *albus* and *Streptococcus pyogenes* are the principal organisms found. It is usually supposed that in wounds healing by primary union and free from suppuration none of these organisms would occur. This observer has examined the secretions of wounds classed as strictly aseptic where primary union occurred, and arrived at the following conclusions: Under antiseptic iodoform dressings only a part (one fifth) of the wound remains quite free from micro-organisms. Result, primary union. In a portion (one half) the *Staphylococcus albus* may be present (in small numbers), and two thirds of these heal by primary union; in the other one third a slight suppuration occurs. In nine cases the *Staphylococcus aureus* and in two the *Streptococcus pyogenes* occurred. Both cause certain suppuration, but by suitable drainage from the start this may be limited to the vicinity of the drain openings.\*

\* "Wien. med. Woch.," "An. of Surg."

The recent investigations of Dr. John E. Weeks, published too late for incorporation in this article, confirm the foregoing statements.

Nélaton, who was counted among the most successful operators, was in the habit of saying that the man who discovered a method of preventing purulent infection would deserve to have erected *in his honor* a statue of gold.

"Lister \* first taught us to apply systematically and accurately a method which would insure for our wounds protection against the hordes of intriguing microbes, and, although his particular method has been simplified and superseded in other countries, the underlying principles remain the same, and subtend all the modifications of the improvers."

The term "Listerism" or "antiseptics" has undergone all manner of misrepresentation and abuse. In a recent article I find it thus erroneously described :

"Listerism, then, is founded on the hypothesis that ordinary atmospheric air contains germs or seeds of disease, which, falling upon the field of operation, develop there, and in that development are answerable for the majority of the unsuccessful results of surgical practice. To prevent that development there was instituted the practice of charging the air surrounding the patient, and especially the field of operation, with a substance which was supposed to have the effect of destroying, or at least of neutralizing, the influence of those germs. As you are all aware, the substance finally selected was carbolic acid. This was employed in the form of a spray to play upon the wound, and of a solution for the hands, instruments, and sponges, in the proportion of  $2\frac{1}{2}$  per. cent., or 1 in 40."

This no more constitutes antiseptics than the ability to successfully extract a corn constitutes a surgeon.

It is the fashion of the day to rail at antiseptics and cry

\* Morris.



for cleanliness ; it should be remembered that this is merely playing upon terms. Ordinary cleanliness is not asepsis ; it is merely an attempt to obey the great moral precept. This has been conclusively demonstrated by Kümmel. Ordinary washing of a part does not give an aseptic surface. If a few scales of the surface epithelium are removed from a part of the skin thus prepared and placed in a cultivation medium, colonies of one or more species of bacteria will develop, and pyogenic forms are not infrequent. "Scientific antisepsis is an exalted degree of cleanliness, but this exalted degree of cleanliness can only be reached through scientific antisepsis."

What chemical purity is to the chemist, and sterilization to the bacteriologist, so is surgical cleanliness or antisepsis to the surgeon.

There is a wide field for research in the determination of the real effect of disinfectants and antiseptics. The subject is so beset with fallacies, leading in some cases to totally erroneous conclusions, that it is not surprising that one meets on all sides with conflicting statements.

According to the investigations of Koch, the salts of mercury, and especially the chlorides, prove most valuable when heat is not permissible, though their poisonous nature, and the fact that the chloride is sometimes changed into inert calomel, is a drawback to their indiscriminate use.

Herroun thinks the value of bichloride of mercury much overrated, as he has cultivated ordinary septic bacteria in albuminous filtrates containing 1 in 2,000. It is precipitated by albumins if used of greater strength, and is readily converted by the sulphur of albuminous bodies into inert mercuric sulphide.

Koch\* has also tested the value of hot air and steam in the destruction of bacteria and their spores. Rolls of flan-

\* Cruickshank.



nel with anthrax spores and a thermometer wrapped up inside were subjected to steam, and the results compared with the effects obtained in hot air.

Thus, in hot air, four hours' exposure to a temperature of  $130^{\circ}$  C. brought the temperature inside the roll to  $85^{\circ}$  C., and the spores were not destroyed; on the other hand, exposure to steam under pressure at  $120^{\circ}$  C. for an hour and a half raised the internal temperature to  $117^{\circ}$  C., and killed the spores. By such experiments the superior penetrative power of steam-heat was established.

Parsons and Klein have shown that complete penetration of an object by steam-heat for more than five minutes is sufficient to kill all bacteria:

Dr. Sternberg has recently published an exceedingly interesting paper upon the heat death-point of bacteria. He concludes that a temperature of  $100^{\circ}$  C., maintained for a period of five minutes, destroys the spores of all the pathogenetic organisms tested (about forty varieties). Most organisms are destroyed at a temperature of  $62^{\circ}$  C.

In this connection it is important to refer to the conclusions of Dr. Fenger in a recent report of a series of investigations:

"What influence the asepsis of the material has on the results of the operations as to death or recovery is a question far beyond the scope of these investigations. It would require a large statistical material of well-observed cases, and more work than could be done by one observer. But it may be safe to conclude that it is desirable to work through an abdominal operation with perfect asepsis everywhere, if such a thing is possible. The above investigations have shown that such perfect asepsis can be attained. Thus, if we are ignorant of the extent of danger from non-sterile material, we are hardly justified in trusting to the innocence or innocuousness of such an uncertainty, while we can have the asepsis of the material an absolute guarantee against the dangers of infection."

The methods of the bacteriologists have made it possible for us to determine with absolute certainty whether the materials used in our operation are sterile or not. By means of cultivation media we may easily determine (1) the condition of the atmosphere in our operating-room, (2) the aseptic condition of the hands, (3) sponges, (4) silk catgut, (5) instruments, etc.

I here present eight cultivation tubes, which were prepared as follows: Previous to two operations performed about a week ago, pieces of the sponges, silk, and catgut to be used were cut off and placed in sterilized tubes; these were carried to the laboratory of the New York Polyclinic, and were carefully placed by Dr. Syms in sterilized peptonized beef gelatin. As you perceive, bacteria have developed in the tube containing a piece of sponge removed at the close of the operation, and in one of the tubes containing a piece of silk; the others have remained sterile. Under the circumstances, the experiments have been too few to give positive conclusions, but they illustrate what may be accomplished by this method. The time at my disposal has been too limited to go into any extended investigation in this direction, but I hope to still further pursue this interesting and practical line of work.

The use of heat as a sterilizing agent by the bacteriologist in the preparation of his pure cultivation, and the uniform result which attends his experiments, has attracted the attention of some of the leading surgeons of Europe, and suggested to their minds that this agent might be employed in the preparation of their antiseptic dressings.

Dr. Robert F. Weir, who has perhaps done more than any other surgeon in New York to popularize antiseptic methods, in a recent lecture referred to this agent as a germicide possessing advantages above the others in "safety, cheapness, and accessibility." You are all familiar with the

disadvantages and defects of the dressings prepared with carbolic acid and sublimate. I therefore desire to describe, in the brief space of time allotted to me, the apparatus, and a method of preparing a form of dressing which is intended to overcome, to a certain extent, some of the difficulties with which we ordinarily contend. Neuber was the first to attempt a systematic method of aseptic wound treatment. Believing that all wound-diseases are due to the action of germs, he seeks to avoid their influence by an improved hospital hygiene, rather than by disinfection with a strong chemical solution. The operation-rooms are especially constructed with a view to cleanliness and drainage. The air admitted to the operation-room is sterilized by first passing it through a furnace and then a cotton filter.

The instruments, sponges, and dressings are sterilized by heat. The hands and region of operation are cleansed and sterilized with a 1-to-1,000 sublimate solution. Only sterilized water is used for irrigation. By these means he hopes to gain an aseptic healing of large operation wounds without drainage. It can hardly be doubted that a wound kept sterile without the lavish expenditure of 5 per-cent. carbolic or  $\frac{1}{10}$ -per-cent. sublimate solutions will heal more kindly than when these chemicals are used, but, as Nussbaum well says, the aseptic treatment of a wound is an ideal realized with great difficulty, the sterilization of a wound still more difficult, and a break in a single link of the chain will destroy the whole. On a recent visit to the Bürger Hospital, Strassburg, I was told by Professor Luecke that all the dressings used were simply sterilized and not impregnated with any chemical whatever, and he showed me an elaborate apparatus for their preparation. Here the most rigid aseptic wound-treatment is conscientiously followed—a circumstance which most certainly has no small share



in the production of the wonderful surgical results reported from this clinic.

The wonderful results of thorough and intelligent anti-septic precautions are perhaps nowhere better shown than in Professor von Bergmann's clinic, in Berlin. All those engaged in the operation are dressed in clean white gowns, and the most careful washing and disinfection of hands is observed before every operation. All the gauze employed for dressings is sterilized by means of steam-heat at a temperature of  $212^{\circ}$  F. This is prepared as follows: After freeing from grease it is placed in a steam sterilizer and exposed to the influence of flowing steam at the temperature of  $100^{\circ}$  C. for a period of fifteen to thirty minutes; by this means it becomes perfectly sterilized. This sterilized gauze, without further treatment, is used for dressings in all but the larger operation wounds, and small tufts are used instead of sponges. In the more serious operation, where profuse secretion is apt to occur from the wound, it is thought best to obtain whatever advantage may be derived from the impregnation of the gauze with corrosive sublimate, as all the operations are performed in the presence of from two hundred to three hundred students who come directly from the anatomical rooms. During the operation the wound is irrigated with a 1-to-2,000 bichloride solution, except in operations on the abdomen, the pleural cavity, the mouth, rectum, and bladder, where 1-to-1,000 salicylic acid or 1-to-200 boric acid is employed.

This convenient little apparatus, here shown, which we owe to American ingenuity, known as the Arnold automatic steam cooker, will be found indispensable to the surgeon.

The sterilization is done by steam under slight pressure, which is generated very rapidly in the small, thin vessel under the pan. The pan is simply a reservoir to keep the steam generator supplied with water as it boils away. The

steam passes up the tube into the drum. In this the perforated receivers or wire baskets are placed and completely surrounded with live steam; in this way gauze, sponges, in-



FIG. 1.

struments, and silk are sterilized at a temperature of  $212^{\circ}$  F. without exposure to air or water. The steam, instead of escaping into the room, is caught by a receiver and condensed, and flows back into the supply reservoir.

With an ordinary Bunsen burner the water boils in less than five minutes, so that in a period of twenty minutes all the materials for an ordinary operation may be prepared.

In private practice the sterilizer may be placed on the cooking range, or a kerosene-oil stove can be used. I ordinarily place the apparatus on a stove near the operating-ta-

ble, so that during the etherization of the patient my materials are being prepared. When the patient is fully anæsthetized, the instruments and silk are removed from the sterilizer, and the dressings left within until needed.

I also exhibit a more complicated apparatus which is a modification of Koch's sterilizer (Fig. 2). It consists of a



FIG. 2.

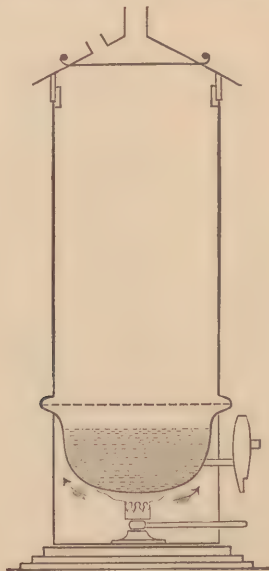


FIG. 3.

cylindrical vessel of strong tin plate, about half a metre or more in length, 25 ctm. in diameter, jacketed with thick asbestos to prevent loss of heat, and provided with a conical cap. The lid is also covered with asbestos, which is perforated at the apex to receive a thermometer. Inside the vessel is an iron grating or diaphragm about two thirds the way down, which divides the interior into two chambers, the upper or steam chamber and the lower or water chamber.



A gauge outside marks the level of the water in the lower chamber; this should be kept about two thirds full. The apparatus stands on three legs and is heated from below with three Bunsen burners. When the thermometer indicates  $100^{\circ}$  C. the lid is removed and the dressings are lowered in a basket by means of a hook and string and the lid quickly replaced.

It requires twenty-seven minutes for the thermometer to indicate  $100^{\circ}$  C. with five pints of water in the receiver, and another fifteen minutes to completely sterilize the material placed within.

I believe the ideal apparatus to be one constructed on this model but made of riveted copper so that the water can be drawn off and the material dried at a temperature of  $212^{\circ}$  F., as indicated in the diagram (Fig. 3).

On removal from the apparatus the dressings dry on exposure of two to three minutes to the air. Or they may be placed in a drying oven for a few minutes.

*Antiseptics in Abdominal Surgery.*—Some few years ago Wegner made the remark that he and his contemporaries had doubtless all been reared in the fear of the Lord and the peritonæum, but now the peritonæum had ceased to be a surgical "*noli me tangere*."

I would be the last to decry the marvelous progress which abdominal surgery has made under the influence of antisepticism, yet I believe that our antiseptic solution can not be used in abdominal surgery with that perfect freedom which has been so efficacious in preventing surgical infection in other classes of operations. Here the enormous absorptive power of the peritoneal cavity dominates the scene. In looking over the records of surgical operations, the deaths from mercurial poisoning are not a few. A recent writer says: "To meet this evil I have gradually diluted my spray and solutions, so as to reduce the whole question to one of clean-

liness, and, I am happy to say, with the effect of very greatly adding to the success of my ovariectomy work." While I can not indorse this practice, yet it has been my endeavor during the past year or so to get along as far as possible without the use of carbolic acid and sublimate during the progress of an abdominal operation, and with the result of making the convalescence of the patient more normal in every respect. To make myself more clearly understood, perhaps I can not do better than give a description of antiseptics as now practiced at the Woman's Hospital, Brooklyn. All efforts are directed with scrupulous care to the disinfection of the instruments and person. The sponges are prepared according to the method described by Dr. Weir, and are used but once. Recognizing and fully appreciating the difficulty of securing at all times the intelligent co-operation of assistants and nurses, the number of assistants who touch anything in connection with the operation is limited to one. All instruments are scrubbed with a brush and soap before and after each operation. Previous to each operation they are placed in the sterilizer for fifteen minutes and then transferred to boiled water. All towels and silk used about the operation are sterilized by boiling. The vessels and basins used about the operation, consisting of glass or granite iron ware, are partially filled with water and placed in an oven for a period of two hours. The water used for sponges and irrigation is boiled and then cooled in covered vessels. The region of operation is washed, shaved, and then cleansed with a saturated solution of iodoform in ether. The room used for the operation is thoroughly cleansed and fumigated before each operation.

This hospital is the first to have a separate building devoted exclusively to abdominal surgery. This pavilion is separated from the main building, not by a space of a few hundred feet, but by a distance of two miles, so that there

is no communication whatever. We now come to the practical question, Do the results justify all these extraordinary precautions and untiring vigilance on the part of the surgeon? In answer to this question I will read you a report of the operations performed in this hospital from January 1, 1887, to December 31 of the same year:

Thirty-five abdominal sections for the removal of ovarian tumors and diseased uterine appendages; of these 35 patients but one died, and this operation was not performed by the regular staff of the hospital.

Twenty of these cases required the use of a drainage-tube.

The abdominal cavity has been opened five times in the removal of cancerous uteri through the vagina; all of these patients have recovered.

There has been one case of suprapubic amputation of the uterus, with its annexa, for myoma, which ended in recovery.

There have been three exploratory incisions; in one of them, a case of peritonitis, the patient succumbed from shock.

There have been four operations for the radical cure of hernia, all of which ended in recovery.

Fifty-two operations for lacerations of the cervix uteri and perinæum; all the patients recovered.

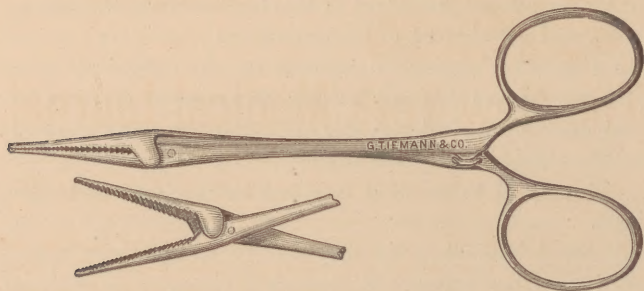
Besides these cases there have been performed in the children's department 14 cuneiform and 22 subcutaneous sections of the bones of the limbs for the cure of deformities, none of which have been attended by serious symptoms.

There have been a variety of other operations which I will not take your time to enumerate. The two deaths above recorded constitute the total mortality.

With one exception, these operations have been performed either by Dr. Mary D. Jones or myself.



I take this opportunity of presenting Collins's new hæmostatic clamp forceps, which is the simplest and most easily cleaned of any forceps with which I am acquainted, and I have adopted it almost exclusively in my practice.



Messrs. Tiemann & Co. have adapted this lock to forceps and scissors of different sizes. The lock is simplicity itself; attached to one blade there is a round pivot, which fits into an opening in the other blade. In order to hold the two blades in close apposition, as the forceps is closed, the male blade passes beneath a projecting arm attached to the female blade, somewhat similar to a Simpson obstetrical forceps. Its advantages are: (1) there are no crevices to hold dirt, so that it can be readily cleaned; (2) the lock can not be twisted off by clumsy nurses; (3) the blades are held firmly together, so that there is no wobbling.



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